Question	Part	Marking guidance	Total marks
01	1	**Mark is for AO2 (apply)** **D** USERINPUT; **If more than one lozenge shaded then mark is not awarded**	1

| 01 | 2 | **Mark is for AO2 (apply)**

B 0;
If more than one lozenge shaded then mark is not awarded | 1 |

| 01 | 3 | **Mark is for AO2 (apply)**

A = ;
If more than one lozenge shaded then mark is not awarded | 1 |

| 01 | 4 | **Mark is for AO2 (apply)**

D OUTPUT count;
If more than one lozenge shaded then mark is not awarded | 1 |

| 01 | 5 | **Mark is for AO2 (apply)**

B i ← i + 1;
If more than one lozenge shaded then mark is not awarded | 1 |

| 01 | 6 | **2 marks for AO2 (apply)**

Maximum of 1 mark if Upper Case Characters given

• 1 mark for a series of more than one correct frequency/value or value/frequency pairs (ignore order of pairs);
• 1 mark for all correct pairs in the correct order;

Correct answer is:
2 t 2 j 3 e 2 s

Other, clear ways to show frequency/value or value/frequency pairs such as '(2, t), (2, j),…' or 't2 j2…'. | 2 |

Question	Part	Marking guidance	Total marks
01	7	**3 marks for AO2 (apply)** Maximum three marks from: • It could be tested with only 1s; • It could be tested with different lengths of input; • It could be tested with an input where the 1s and 0s vary; • It could be tested with an input where the last two numbers are different; • It could be tested with the empty string; • It could be tested with a string of length one; • It could be tested with two runs of 0s separated by a run of 1s / two runs of 1s separated by a run of 0s; • It could be tested with invalid data (such as 1010abc); Any other correct reasoning as long as clearly distinct from other mark points. **R.** not enough tests are carried out.	3

02	1	**3 marks for AO2 (apply)**		3

Character	Binary Code
G	10;
S	110;
H	111;

02	2	**4 marks for AO2 (apply)**	4

66 (bits);;;;

A. other answers if they **are correct based on incorrect answer provided for 13.1** but only if the working has been shown.

If the answer given is not correct based on their answer to Q 13.1, a maximum of 3 working out marks should be awarded as follows:

Huffman Tree Calculation

5*1 + 4*2 + 2*3 + 2*3 // 25 (bits) // (length of) 0010111111101011000011010 (1 mark);

A. a calculation that results in an answer that is not 25 bits as long as the maths is all correct (ie incorrect frequencies or bit counts have been used)

ASCII Calculation
13 characters * 7 bits // 91 (bits) (1 mark);

Calculate Saving
Subtracting ASCII bit total minus Huffman bit total (1 mark);

Example 1 Incorrect Huffman Tree Calculation

This table below shows **incorrect** codes given by a student.

Character	Binary Code
A	0
G	010
S	0110
H	0111

5 (Letter A freq) * given length +
4 (Letter G freq) * given length +
2 (Letter H freq) * given length +
2 (Letter S freq) * given length

5 * 1 +
4 * 3 +
2 * 4 +
2 * 4 = 33 bits

If performed correctly based on binary code lengths given in answer 13.1 this would be given 1 mark.

Student gets ASCII length correct (this would be given 1 mark)

If the student then used this value to calculate the saving 91 bits – 33 bits = 58 then this would be given 1 mark.

A total of 3 marks would be given.

Example 2 Incorrect Huffman Tree Calculation

This table below shows **incorrect** codes given by a student.

Character	Binary Code
A	0
G	010
S	0110
H	0111

5 * 4 + (incorrect length)
4 * 4 + (incorrect length)
2 * 4 +
2 * 4 = 52 bits

Calculation is correct but lengths are wrong based on binary code lengths given in answer 13.1 (this would be given zero marks).

Student gets ASCII length correct (this would be given 1 mark)

If the student then used this value to calculate the saving 91 bits – 52 bits = 39 bits then this would be given 1 mark.

A total of 2 marks would be awarded.

03	1	**1 mark for AO2 (apply)** LEAST; **A.** Any text sentence such as 'the string represents the word LEAST'; **I.** upper/lower case.	1

03	2	**2 marks for AO2 (apply)**	2

S	T	A	R
1010	1011	00	01

1010 1011 00 01;;

2 marks for **all four** codes correct ;;
1 mark for **any two** codes correct ;

A. Clearly written codes that are correct as shown above, even if they are not written in the table.

Qu	Part	Marking guidance	Total marks
04	1	**Mark is for AO1 (recall)** **C** The process of encoding information to try and use fewer bits than the original; **R.** if more than one lozenge shaded.	1

Qu	Part	Marking guidance	Total marks
04	2	**2 marks for AO1 (understanding)** A **maximum of 2 marks** can be awarded. Example mark points include: • To speed up file transfer; • To use less storage (capacity); • (It could) save money if you use less bandwidth; • To use less memory; • (It could) save money if you use less storage capacity;	2

Qu	Part	Marking guidance	Total marks
04	3	**Mark is for AO1 (understanding)** (The data) contains lots of runs; **A.** repeating values	1

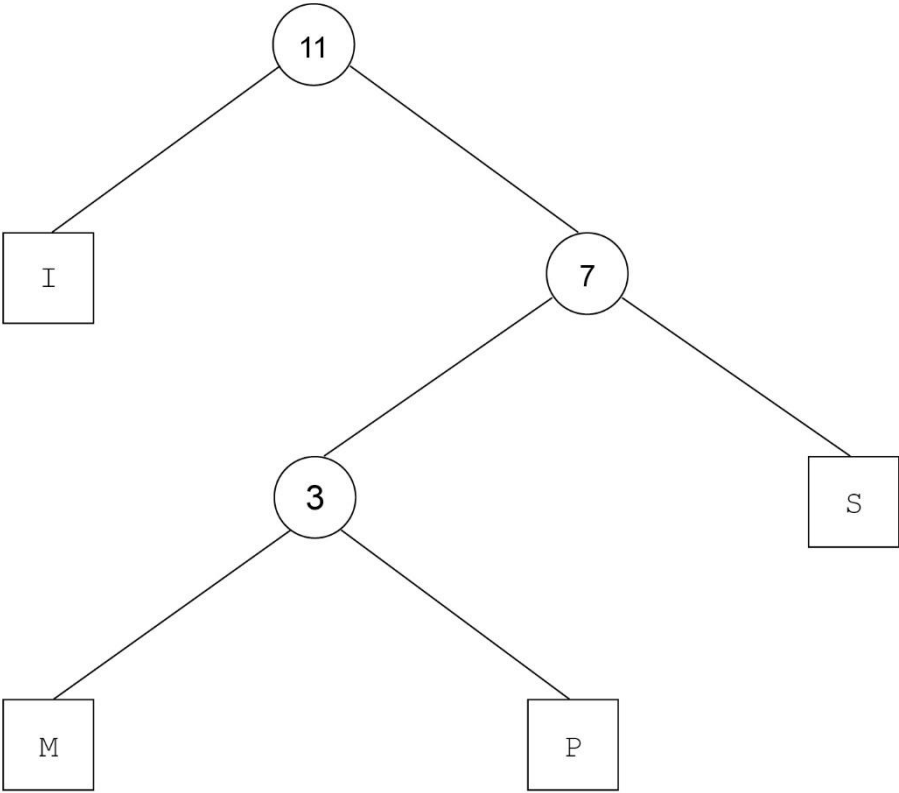| Qu	Part	Marking guidance	Total marks
04	4	**2 marks for AO1 (understanding)** **How it works** (max 1 mark) • the number of consecutive pixels/data points/characters of the same colour/value/character would need to be counted; • (pairs of values would be stored), which would consist of a run length and the colour/value/character of the pixels/data points/text in the run; **Example** (max 1 mark) • Image example of how the specific row of pixels would be compressed eg 9 Black, 11 Red, 8 White; • Text example of how the specific run of characters would be compressed eg 7 G, 6 Y, 12 $ **A.** run length and data value either way round.	2

Qu	Part	Marking guidance	Total marks

| 05 | 1 | **3 marks for AO2 (apply)**

1 mark for any one character correctly encoded
2 marks for any three characters correctly encoded
3 marks for all characters correctly encoded | 3 |

M	**O**	**S**	**T**
10111	10110	010	111

| 05 | 2 | **4 marks for AO1 (understanding)**

1 mark for each of the following:

• the characters with the highest frequencies should not be combined // the characters with the lowest frequencies should be combined;
• the frequency table should not be sorted alphabetically // the frequency table should be sorted in order of frequency;
• the letter S does not have the highest frequency in Figure 2 // E has the highest frequency;
• the new node should not be added to the end of the frequency table // the new node should be inserted in the correct place based on the combined frequencies; | 4 |

Qu	Part	Marking guidance	Total marks
05	3	**2 marks for AO2 (apply)** 122 (bits);; If the answer given is not 122 bits, a **maximum of 1 working out mark** should be awarded as follows: **ASCII Calculation** 36 characters * 7 bits // 252 (bits); **Calculate Saving** Subtracting 130 from any other value;	2

Qu	Part	Marking guidance	Total marks
06	1	**2 marks for AO1 (understanding)** Maximum of **two** marks from: • to reduce file size // to decrease the amount of storage needed; **NE.** Take up less space • to make it faster to transmit/receive/read/write/access; • (it could) save money if you use less bandwidth // (it could) save money if you use less storage capacity; • to use less memory; **NE.** Take up less space	2

Qu	Part	Marking guidance	Total marks
06	2	**2 marks for AO2 (apply)** Maximum **two** marks from: • The data do not have a high frequency of consecutive repeating characters; • The (compressed) data will take up more storage space/be longer than the original/uncompressed data; **2 marks** if a valid point is made along with a suitable valid expansion	2

Qu	Part	Marking guidance	Total marks
06	3	**Mark is for AO2 (apply)** **One** mark for **all characters** in the correct position. ![Huffman tree diagram: root node 11 with left child leaf I and right child node 7; node 7 has left child node 3 and right child leaf S; node 3 has left child leaf M and right child leaf P]	1

Qu	Part	Marking guidance	Total marks
07	4	**2 marks for AO2 (apply)** **1 mark** for the left-hand eight bits correct; **1 mark** for the right-hand eight bits correct; | 1	1	0	0	0	0	0	0		0	0	0	0	1	1	1	1 | If **neither** of the mark points above have been awarded then award a **maximum of 1 working mark** as follows: 1 mark if the first bit is 1 **and** the ninth bit is 0; 1 mark if right-hand seven bits of each byte are correct;	2

Qu	Part	Marking guidance	Total marks
08	7	**All marks AO2 (apply)** | Character	Huffman coding | |---|---| | O | 111 | | SPACE | 10 | | B | 00110 | **Mark as follows:** **1 mark** per correct response	3

Qu	Part	Marking guidance	Total marks
08	8	**1 mark for AO1 (understanding) and 2 marks for AO2 (apply)** 7; * 26; = 182 182 – 83; = 99 **Mark as follows:** **1 mark for AO1:** identifying number of bits (7) used to represent an ASCII character; **1 mark for AO2:** multiplying by 26; **1 mark for AO2:** subtracting 83 from their answer for the number of bits used to represent the ASCII version of the text; **A.** Incorrectly calculated number of bits used for ASCII version **Maximum 1 mark:** for correct answer with no working out shown	3

Question	Part	Marking guidance	Total marks
09	**1**	**2 marks for AO2 (apply)** A**;** DDED; **I.** quotes around response **Max 1 mark** if any punctuation other than quotes	2

Question	Part	Marking guidance	Total marks
09	**2**	**3 marks for AO2 (apply)** 95 (bits);;; If the answer given is not fully correct then award **a maximum of 2 working marks** as follows: **Huffman coding calculation** 6*2 + 5*2 + 4*2 + 3*3 + 2*3 // 15*2 + 5*3 // 45 bits // 01110111000001111001011011100000010110111011; **A.** a calculation that clearly attempts to multiply the frequency of each character by the number of bits for that character but has arrived at wrong total **ASCII calculation** 20 (characters) * 7 (bits) // 140 (bits); **A.** a calculation that clearly attempts to multiply 20 by 7 but has arrived at wrong total **Bit saving calculation** Subtracting Huffman bit total from ASCII bit total; (even if totals used are incorrect, as long as it is clear that there is an ASCII bit total and a Huffman bit total).	3